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FIFTY-MAN SPACE BASE POPULATION ORGANIZATION

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16. ABSTRACT

As long as a space facility has a small population (e.g., 6 to 12 people), there seems to be no reason for any concern about overseeing the activities and providing for smooth operations and the well-being of everybody on board. However, if we begin to plan for populations of 50 to 100 individuals within a space facility, problems pertaining to organization, population structure, and discipline may arise. This may be especially true considering the integration of different social groups such as engineers, technicians, scientists, and facility command personnel.

In this report, an attempt is made to establish a baseline social and functional structure for a 50-man Space Base and to show how the requirements and activities of the personnel affect the Space Base layout.

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SUMMARY

As long as a space facility has a small population (e. g. , 6 to 12 people), there seems to be no reason for any concern about overseeing the activities and providing for smooth operations and the well-being of everybody on board. However, if we begin to plan for populations of 50 to 100 individuals within a space facility, problems pertaining to organization, population structure, and discipline may arise. This may be especially true considering the integration of different social groups such as engineers, technicians, scientists, and facility command personnel.

In the following discussion, an attempt is made to establish a baseline functional structure for a 50-man space base and to show how the requirements and activities of the personnel affect the space base layout.

INTRODUCTION

NASA is planning a 50- to 100-man earth orbital space base for the 1980's. Compared with the smaller space stations, manned with from 3 to 12 people, which are planned for the 1970's[1], the population of a large space base will be a miniature society which will require a structure in order to sustain itself and to function properly[2].

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1. NASA Statement of Work - Space Station Program Definition (Phase B), Appendix A.

2. Sells, S. B.: A Model for the Social System for the Multiman Extended Duration Space Ship. Dissertation, Texas Christian University, Fort Worth, Texas, March 1966. The only past effort in this area, as far as could be established, was done by Dr. Sells.

GROUP PHENOMENA

In general, people behave differently as members of a group than they do as individuals. Members of a group relate to each other in many ways — friendly, indifferent, or hostile. If a group is unstructured, that is, without a leader, these different attitudes can build up and ultimately either make the group ineffective or destroy it. If a group is or becomes structured, then it can become a closely formed organism by resolving negative attitudes and reinforcing positive ones, thus becoming an effective team.

Group Size

Experience in numerous organizations and with a great variety of teams has shown that group coherence requires a certain optimum group size. Large groups, such as 50 people, are generally unable to function as a closed entity because communication problems between members are too great. As a result, subgrouping occurs. A small group, such as three to five people, also suffers under insufficient bases for communication; as a result pairing occurs. The optimum size of an effective group lies between 7 and 12 individuals.

Group Relations

A structured group of people in confinement (prison, submarine, exploration team, Space Base) can quickly develop the following important characteristics of a good team, as long as the number of people is within the optimum size range:

1. Unquestioning acceptance of themselves and others.

2. Natural behavior.

3. Problem centering; feeling of responsibility, duty, or obligation.

4. Aloofness and calm; independent judgement.

5. Autonomy — Independence of the physical and social environment.

6. Interpersonal Relations — Tendency to be patient with everyone of suitable character, regardless of class, education, political belief, race, or color.

7. Creativeness, originality, inventiveness.

It is concluded that a 50-man Space Base population needs to be structured into subgroups of nearly optimum size, and that an overall social structure should be established in order to provide for the well-being and efficient performance of the Space Base population.

SPACE BASE SOCIAL AND ORGANIZATIONAL STRUCTURE

In the following, an attempt is made to establish a baseline social and functional structure for a 50-man Space Base and to show how the requirements and activities of these personnel affect the Space Base layout. Many of the assumptions may seem arbitrary because of lack of precedent, but it appears that this baseline may serve as a point of departure.

No similarities have been found with either strictly military-discipline-oriented crew operations or with civilian science-administration-oriented institutions. Therefore, for the Space Base, a mixture of a military-type discipline and a free and scientifically oriented organization is envisioned.

Space base personnel are divided into three groups: (1) Base Command and Management Group, (2) Base Operations Group, and (3) Scientific Faculty Group. Figure 1 shows the organizational structure of the three groups and the number of personnel for each group.

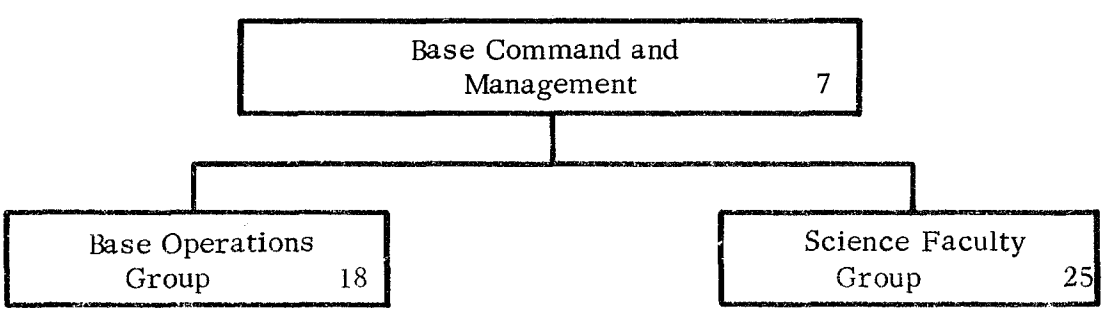

Figure 1. Space base personnel organizational structure.

Base Command and Management Group

Table 1 lists the division of personnel for the Base Command and Management Group. The Base Commander has full authority on all matters concerning the Base, its operations and the scientific planning. The two Deputy Commanders have full authority within their respective areas of operations and science; they are in full command if representing the Commander. The four Directors have full authority and responsibility in their areas — logistics, communication, maintenance, and personnel.

TABLE 1. BASE COMMAND AND MANAGEMENT GROUP PERSONNEL STRUCTURE

Position	Discipline	Number
Space Base Commander		1
Deputy Commander Operations		1
Director Logistics	Administrator	1
Director Communications	Electron. Eng.	1
Director Maintenance	Mech. Eng.	1
Director Personnel	Administrative	1
Deputy Commander Science	Science/Admin. Ph. D.	1
	Total	7

Base Operations Group

This group consists of the personnel listed in Table 2. Communications, Navigation, and Data Handling personnel report to the Director Communications. Power, Computer, EC/LS, and Maintenance personnel report to the Director Maintenance. Flight Controllers and the Medical Staff report to the Director Logistics.

TABLE 2. BASE OPERATIONS GROUP PERSONNEL STRUCTURE

Subgroup	Discipline	Personnel	
		Type	Number
1	Communications	Technicians	2
	Navigation	Engineers	2
	Data Handling	Technicians	2
2	Power	Engineer	1
	Central Computer	Technician	1
	EC/LS Systems	Engineers	2
	Maintenance	Technicians	4
3	Flight Controller	Specialists	2
	Medical Staff	M. D. 's	2
		Total	18

Scientific Faculty Group

The Scientific Faculty is under the administration of the Deputy Commander Science. The personnel organization for this group is shown in Table 3.

TABLE 3. SCIENTIFIC FACULTY GROUP PERSONNEL STRUCTURE

Subgroup	Discipline	Personnel	
		Type	Number
1	Astronomy	1 Ph. D., 2 Assist.	3
	Physics, High Energy	1 Ph. D., 1 Techn.	2
	Materials	1 Ph. D., 2 Techn.	3
2	Biology	1 Ph. D., 2 Assist.	3
	Biotechnology	1 Ph. D., 2 Assist.	3
	Biomedical	1 Ph. D., 1 Assist.	2
3	Earth Resources	2 Ph. D., 4 Assist.	6
	Others		3
		8 Ph. D., 11 Assist., 3 Techn., 3 Others	25

In summary, a typical Space Base population has the representative composition shown in Figure 2.

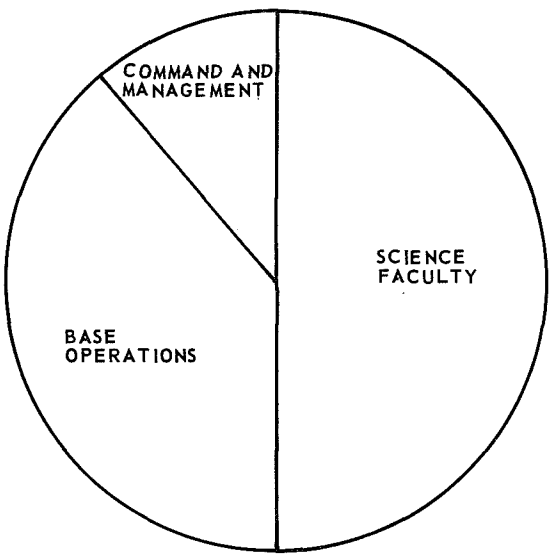

Figure 2. Space Base population distribution.

SHIFT OPERATIONS

The Base Command and Management Group and the Base Operations Group work three shifts, continuously rotating responsibilities within these two groups (Table 4).

1. First Shift — This is the main "day" shift. The Commander and his four Directors are on duty. One each of the Base Operations Group will be on duty. One each (but two earth resources) of the Scientific Faculty will be on duty. A total of 21 persons are on "day" shift.

2. Second Shift — The Deputy Commander Operations is in command. The number two men from Base Operations will be on duty. (The computer man does duty on power.) The number two men from Scientific Faculty will be on duty (but numbers three and four of earth resources). Seventeen persons form Shift Two.

3. Third Shift — The Deputy Commander Science is in command. The Base Operations Group is represented by four specialized maintenance personnel as follows: one — communication; one — navigation; one — data and power; and one — EC/LS. The Science Faculty is represented by their number three men (numbers five and six of earth resources), with no biomedical and physics. There are 12 persons on the third shift.

This provides the necessary safety and functional readiness of the Base. The Scientific Faculty's tour of duty will depend on its specific program, earth or sky visibilities, observation times, etc.

In general, there should be one common day of rest for all, with only critical systems being monitored, but without specific internal operations or any external flight operations. The day of rest has the following personnel and their alternates on duty for a three-shift tour of duty: commander; one — communication; one — power; one — EC/LS; and one — navigation.

TABLE 4. THREE-SHIFT OPERATION[a]

First Shift	Second Shift	Third Shift	Rest Day
Commander	Dep. Com. Ops.	Dep. Com. Science	Active
Dir. Log.			
Dir. Com.			
Dir. Maint.			
Dir. Pers.			
Com. 1	Com. 2	Maint. 1 (Com.)	Active
Navig. 1	Navig. 2	Maint. 2 (Nav.)	Active
Data 1	Data 2	Maint. 3 (Data)	
Power	Comp.	Maint. 3 (Data)	Active
EC/LS 1	EC/LS 2	Maint. 4 (EC/LS)	Active
Flight Cont. 1	Flight Cont. 2		
Med. 1	Med. 2		
Astron. 1	Astron. 2	Astron. 3	
Biol. 1	Biol. 2	Biol. 3	
Biotech. 1	Biotech. 2	Biotech. 3	
Biomed. 1	Biomed. 2		
Phys. 1	Phys. 2		
E. R. 1 + 2	E. R. 3 + 4	E. R. 5 + 6	
Material 1	Material 2	Material 3	
Other 1	Other 2	Other 3	
Total 21	Total 17	Total 12	5 Per Shift

a. Each shift is 8 hrs/day, 6 days/week.

SPACE BASE LAYOUT PLANNING

The rotating hub (Figs. 3, 4, and 5) is a natural barrier for frequent traffic and supply from the Central Station into the Rotating Station and between segments of each. Therefore, Base activities with close relationships and interfaces will be located within specific segments of the Base, thus requiring a minimum of traffic.

Central Station segments are fore and aft of the hub, and are designated as C_1 and C_2. Rotating Station segments, located at each rotating arm, are designated as R_1, R_2, etc. Base Command and Management will have its proper location in the middle of the Base. Base Operations is located at C_2, with the bulk of all Base subsystems. The Science Faculty is located at C_1, with the laboratories.

The individual floor space allotment within the Space Base is shown in Table 5.

TABLE 5. SIZING OF LIVING QUARTERS[a]

Living Quarters (700 ft^2/floor useful space; 100 ft^2 = 1/7 floor)	Floor
Base Command and Management Group (7)	
Single rooms, 100 ft^2 each	1
Base Operations Group (18)	
Single rooms, 50 ft^2 each (min)	1 1/2
Scientific Faculties (25)	
Single rooms, up to 100 ft^2 each (50 ft^2 sleeping, 0-50 ft^2 working requirements to be determined)	3 4/7
1 dining room 10 persons (including food prep.)	1/2
1 dining room 20 persons (including food prep.)	1
2 assembly rooms 10 persons	1
1 assembly room 20 persons	1
2 document centers	2/7
6 toilets with showers	6/7
2 sick bays	4/7

a. 33-foot-diameter Base Elements.

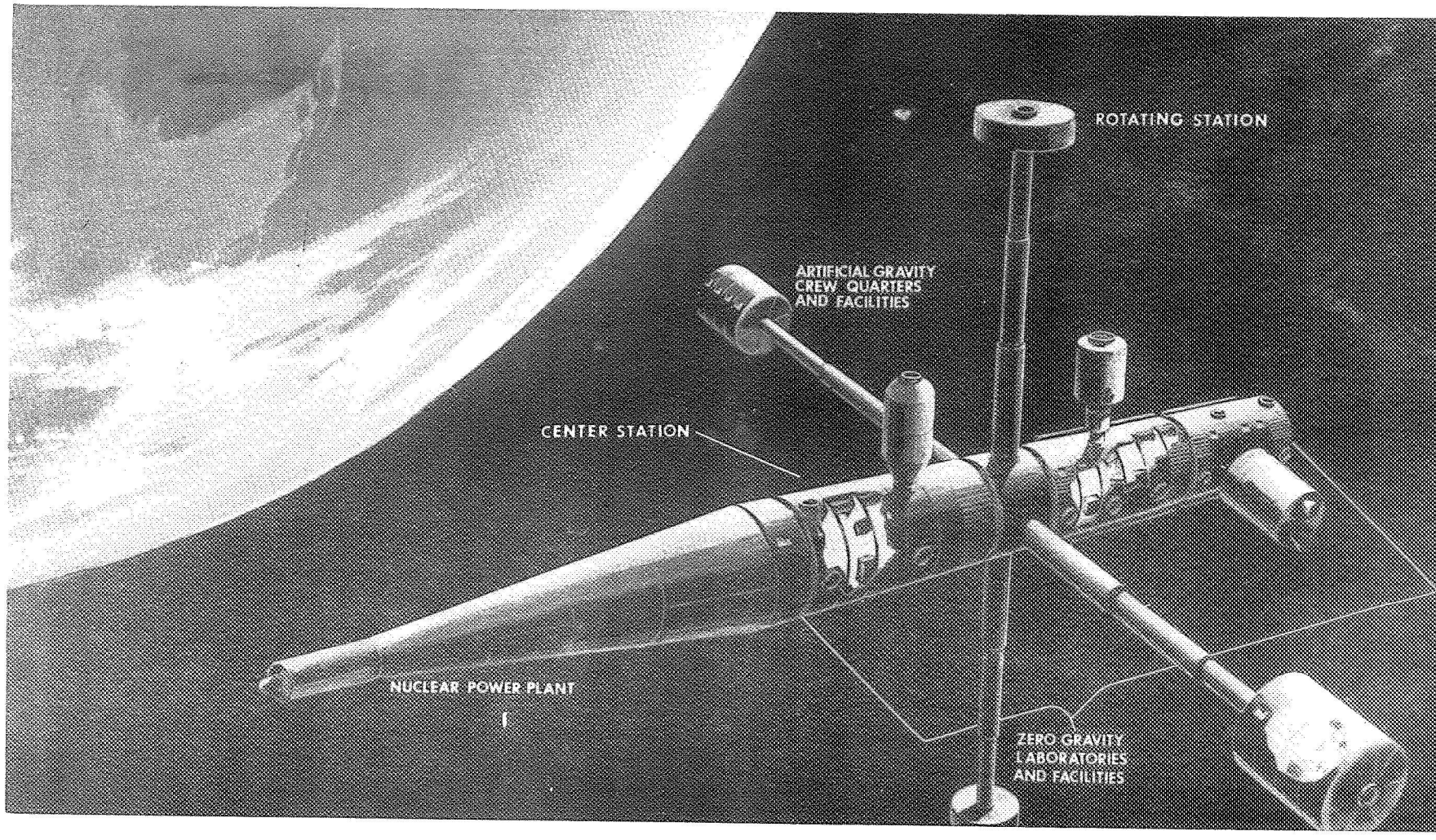

Figure 3. Space Base

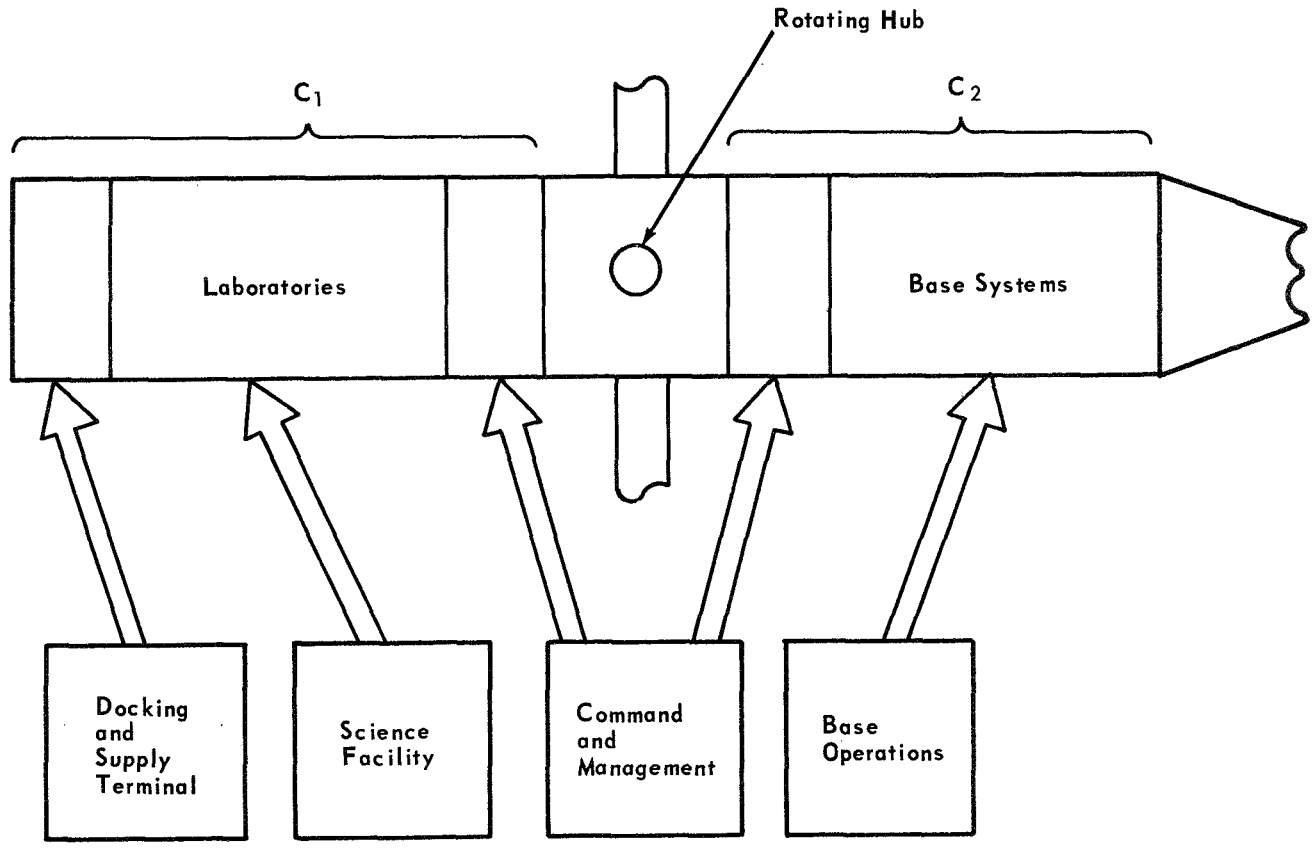

Figure 4. Center station — distribution of activities.

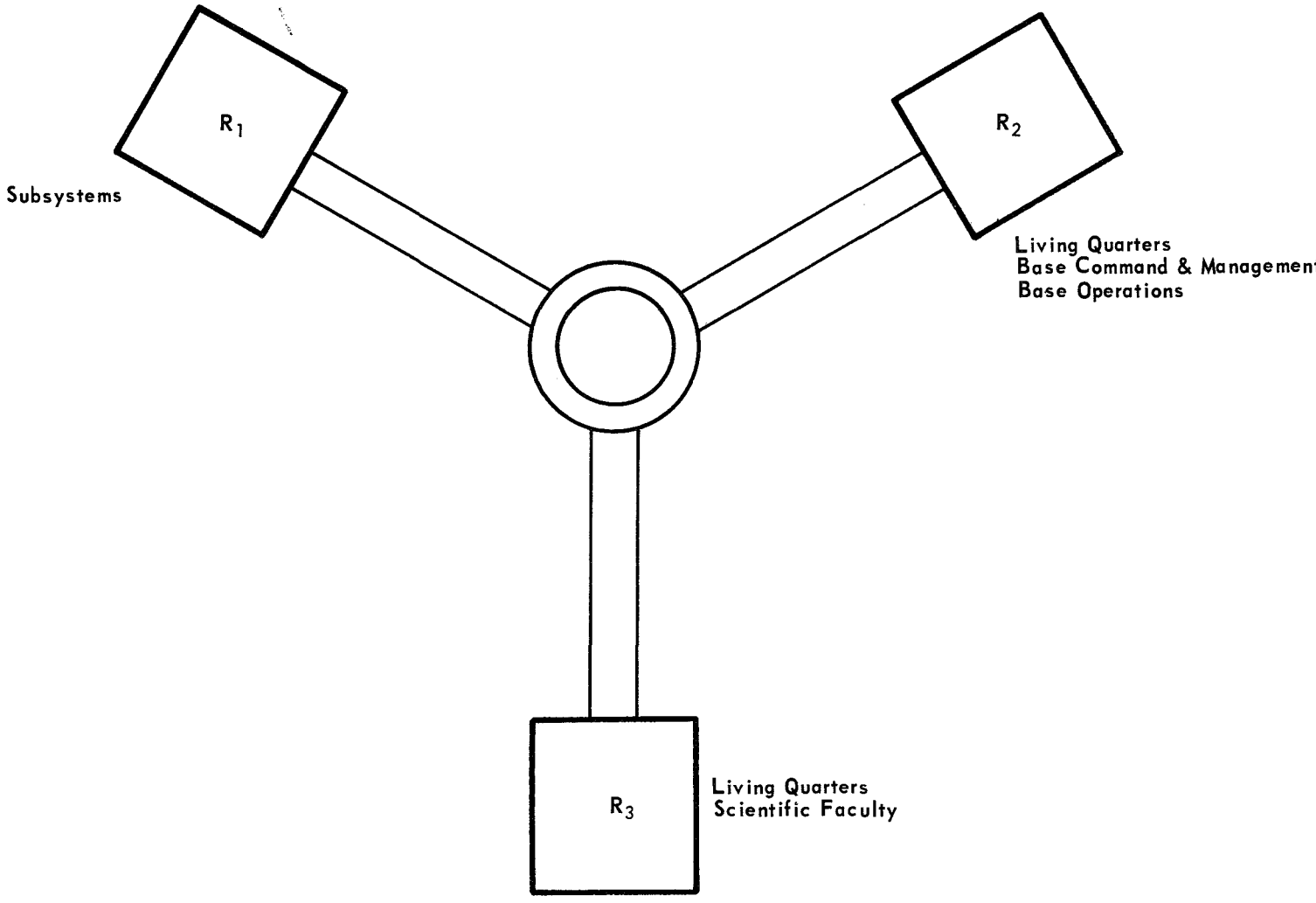

Figure 5. Rotating station — distribution of activities.

Having established the population structure, their working relations, and space allotments, a point of departure is available to structure the Space Base layout. We are considering a Space Base with a weightless portion and, in addition, a rotating portion for an artificial gravity environment.

Distribution of living quarters is the following:

1. A full contingent of living quarters will be located in the Rotating Station (6 floors).

2. One-half of the Base population will have duplicate living quarters in the Center Station. This is the whole Science Faculty (25 people, 3 4/7 floor). The scientists most likely want to stay with or near their laboratories and experiments which are in the Center Station. Besides, the possible ill effects of alternating between the weightless state and the artificial weight state may be most pronounced with untrained scientists.

3. A dining room for 20 persons, an assembly room for 20 persons, and a document center will be located in the Center Station, where most people are during duty cycles and where they can eat and meet (2 1/7 floor).

4. A dining room for 10 persons and two assembly rooms for 10 persons each will be located in the Rotating Station (1 1/2 floor).

5. Three toilets with shower will be located in the Center Station. They are distributed so that one each is in the two end segments and one is in the center segment (3/7 floor).

6. One toilet with shower will be in each module of the Rotating Station (3-4 facilities, 1/7 floor each, 3/7 to 4/7 floor).

7. A document center will be in one rotating module. Documents can be handled easier in artificial gravity (1/7 floor).

8. A sick bay will be in the Center Station near the docking end (2/7 floor).

9. A sick bay will be in the Rotating Station (2/7 floor).

The distribution of living quarters is shown in Table 6.

TABLE 6. DISTRIBUTION OF LIVING QUARTERS

	Floors	
	Rotating Station	Center Station
Base Command and Management	1	
Base Operations	1 1/2	
Scientific Faculties	3 4/7	3 4/7
Dining Room (20 persons)		1
Assembly Room (20 persons)		1
Document Center	1/7	1/7
Dining Room (10 persons)	1/2	
Assembly Room (10 persons)	1/2	
Assembly Room (10 persons)	1/2	
Toilet and Shower	3/7	3/7
Sick Bay	2/7	2/7
	8 3/7	6 3/7
	5900 ft^2	4500 ft^2

CONCLUSION

By structuring the Space Base population into three branches — Command, Operations, and Science — a way is shown to structure the Space Base layout along functional disciplines. In order to establish a baseline population and base structure, certain assumptions relative to floor space were made. As detailed studies progress, these numbers can be updated without affecting the overall philosophy.

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The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

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